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ABSTRACT

Institutional space at the University of Montreal was examined in relation to program structure, student credit hour flows, and departmental services performed to the community. A distance matrix representing the relative location of departmental units on campus, and an attribute matrix, relating places and attributes of these places, were assessed. The data in the distance matrix were collected over 59 departmental units on the basis of a regionalization of the campus according to "centroids" of buildings, and the distance expressed in minutes of walking from centroids of one unit to those of another. The data in the attribute matrix were collected over 54 departmental units and include the accessibility of aggregate distance (in walking time) of each unit. A formal or structural category includes the size of student credit hour flows, the teaching load, and program structure, while a functional category includes the number of student credit hours from extra-departmental origins. Flow matrices were also used to describe the movement characteristics of 42 units of origin to 10 destination areas corresponding to major disciplinary groups. Among the study implications are the following: structural characteristics of units such as expressed by the dimensions of program multidisciplinary breadth and size of activities can be advantageously used to improve the quality of space allocation on campus. Program multidisciplinary breadth may indicate interaction potential as well as dependency on the community for the provision of academic services. The structural characteristics of units can be further analyzed in terms of relative location of interacting units, accessibility, and centrality. (SW)

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SWITCHING FROM QUANTITY TO QUALITY OF SPACE ALLOCATION

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Mary Corcoran
University of Minnesota
(Editor, AIR Forum Publications)

ABSTRACT

This paper considers institutional space with new eyes in attempting to determine the spatial qualities of program structures, student-credit-hour flows and departmental services performed to the community. It describes the University academic units as a spatial network which can be analyzed for its centrality, and its functional and locational complementarities. It seeks to develop a new methodology for analyzing spatial relationships on campuses and draws from these results to suggest alternative space allocation procedures.

SWITCHING FROM QUANTITY TO QUALITY OF SPACE ALLOCATION

In the late 60s and early 70s, a great deal of attention was paid to efficient space allocation (Dober and Mason, 1965), year-round operations (Suslow and Riley, 1968; Hopkins, 1973), and class scheduling patterns (Smith and Wagner, 1972) to make room for students. There were also concerns about utilizing space in a way that would suit best interdisciplinarity and academic program structures (Mason, 1969; Simha, 1977). Then came a declining college-age population coupled with rising costs which put instructional space and building maintenance on the back burner.

Besides preoccupations that were driven by economics, there has been relatively little in way of studying the formal and functional spatial organization of the various academic units. However, general studies in the field of transportation geography have exemplified how different points of a network system are hierarchically linked to each other (Nystuen and Dacey, 1961; Clark, 1973; Wiseman, 1976). These analyses have been applied to a variety of problems such as taxi trips in large cities (Goddard, 1970), goods movements (Britton, 1971) and other flow pattern situations. The induced course load matrix (Suslow, 1976) has been used to determine the amount and direction of course credit flows across departments; it does not deal with the spatial aspect of the units. This qualitative dimension is more difficult to measure but plays a very instrumental role to promote and support institutional goals towards a pre-determined vision of what the preparation of an educated person entails (Harvard, 1978; University of Toronto, 1979).

This study is aimed at examining the spatial structure and behavior of the formal and functional interaction among academic disciplines. The formal

spatial organization studies a set of attributes such as the relative location of units, their accessibility, the volume of student-credit-hours they generate, and other characteristics which contribute to explain the interaction network. The functional spatial organization refers to the ways in which the attributes interact and focus on the flow - origin and destination - and hierarchy of student-credit-hours across departments.

METHODOLOGY

Data

Four matrices are used to analyze the relationships that exist between form and function. The elements of form are described in two matrices, a distance matrix representing the relative location of departmental units on campus, and an attribute matrix, whose rows are made up of places and whose columns consist of the attributes of these places. Similarly, the elements of function are described by two flow matrices of student-credit-hours whose rows are origins of the flows and whose columns are destinations.

The data in the distance matrix were collected over 59 departmental units on the basis of a regionalization of the campus based on centroids of buildings. This distance is expressed in minutes of walking from the centroids of each unit to the centroids of every other unit.

The information in the attribute matrix was collected over 54 departmental units (five units being withdrawn from this analysis for lack of information). For each unit, information on spatial, formal and functional characteristics of units was gathered. The 'spatial' category includes the accessibility or aggregate distance (in walking time) of each unit in relation to the entire

spatial system. The 'formal' or structural category includes the size of student-credit-hour flows, the teaching load and the program structure expressed in terms of "minimum and maximum" theoretical multidisciplinary provisions. The 'functional' category includes the attraction or service component of each unit defined as the number of student-credit-hours from extra-departmental origins, and the number of departmental units attracted by this service component.

The flow matrices describe the movement characteristics of 42 units of origin to 10 destination areas corresponding to major disciplinary groupings (see Table 1). The aggregation of destinations into 10 major disciplinary areas and of origins into 42 was made necessary by the presence of numerous zeros in

TABLE 1 - DISCIPLINARY AREAS

I Basic Health Sciences	II Humanities	III Natural Sciences	IV Social Sciences
Anatomy	Ancient and Modern Studies	Chemistry	Criminology
Biochemistry	Anthropology	Computing Science	Psychology
Biology	History	Mathematics	Social Work
Micro-Immunology	Philosophy	Physics	Sociology
Pathology	Theology		
Pharmacology			
Physiology			

V Languages and Civilizations	VI Architecture and Earth Sciences	VII Education	VIII Para-Medical Sciences
English	Architecture	Andragogy	Dentistry
Ethnic Studies	Geography	Audio-Visual Technology	Health Administration
Arab	Geology	Comparative Education	Nursing
East Asiatic	Industrial Design	Elementary Education	Nutrition
French Canadian	Landscape Architecture	Evaluation in Education	Optometry
Jewish	Urban Planning	Orthopedagogy	Pharmacy
French		School Administration	Physical Education
Linguistics		Secondary Education	Re-Education
Translation			Speech Therapy

IX Communication	X Social-Political Sciences	
Communication Sciences	Demography	N.B.: The Engineering and Administration Schools are affiliated to the University. They have been excluded from this analysis.
Music	Economics	
Visual Arts	Industrial Relations	
	Law	
	Political Science	

the original 59 x 59 flow matrices indicating the narrow spectrum of interaction between departmental units. The resulting 42 x 10 flow matrices describe the interaction patterns: 1) one matrix, the Optional Flow Matrix, describes the inter-departmental student-credit-hour flows constituted solely of electives. This eliminates the effect of compulsory extra-departmental flows embedded in the program structures; 2) another matrix, the Total Flow Matrix, represents the interaction resulting from all inter-departmental flows of student-credit-hours including compulsory and optional flows.

Method of Analysis

The research strategy used in this study is threefold: 1) compare departmental units on the basis of their similarities; 2) classify units on the basis of their flow relationships; and 3) identify interdependencies between the different resulting classifications which are representations of the formal and functional characteristics of departmental units.

A principal component analysis was used to evaluate similarities and flow characteristics of departmental units. Principal component analysis is a multivariate technique for expressing a matrix of m groups of attributes (or variables) measured over n areas (or units) in terms of r orthogonal dimensions ($r \leq m$) variables. By considering both factor loadings and factor scores simultaneously, a more precise indication of the functional nature and zonal composition of the factors is obtained. High loading zones represent the salient destinations of factor patterns. Factor scores represent the relative importance of flows from a particular zone to the pattern of flows identified by the dimension. Thus, zone with high scores on a particular dimension, bearing the same algebraic sign as the factor loadings, can be viewed as important origin

points for the pattern of flows depicted by this dimension.

A hierarchy of flows and a classification of departmental units can also be achieved on the basis of the principal dimensions resulting from the analysis.

ANALYSIS

Formal Organization

Following findings from different authors (Harman, 1960; Berry, 1966) that the organization of communication or interaction systems involves both spatial and formal structural dimensions, the groups of variables of the attribute matrix (7 in all) described in the last section were subjected to a principal component analysis from which emerged three dimensions. The first two dimensions with eigenvalues greater than 1 explain a total of 79,6% of the variance contained in the original variables. The third variable with an eigenvalue of 0,9 explains the remaining 20,4% of the variance (see Table 2).

Table 2 - Dimensions of Formal Spatial Organization

Dimensions	I	II	III
Eigenvalues	2,2	1,3	0,9
Percent Variance	50,2	29,4	20,4
Comulative Percent Variance	50,2	79,6	100,0

The first dimension is characterized by high positive loadings on the program multidisciplinary provisions and no major contribution from the other attributes on this factor (see Table 3). This is clearly a program structure component and its interpretation is facilitated by the patterns of scores shown in Table 4 and Appendix 1.

The second dimension identifies the attraction power of departmental units. The two variables loading high on this dimension, "number of interacting units" and "attraction", can also be said to describe the service component of departmental activities. The loadings of the two variables further show that the range of units served by any single department is more important than the size of the service provided as expressed by the variable attraction.

The analysis of factor scores (Table 5) identifies the particular units which provide differential levels of service to the community.

Table 5 - Zonal Composition of the Service Dimension

	Factor Scores			
	+ 2,0	1,6 to 2,0	1,1 to 1,5	0,5 to 1,0
Units	Anc. & Mod. Studies	Computing Sc. English Psychology	Anthropology Physics Mathematics History Visual Arts Philosophy	Audio-Visual Techn. Communication Economics French Geography Linguistics Sociology

These particular units are expected to be significant destination points for inter-departmental student-credit-hour flows.

The third dimension loads highly on the "size" and "teaching load" variables and can be said to describe the activity level of the units. Units possessing the highest positive scores on this factor are high-activity centers and usually are attractive to the extra-departmental students. However, attraction is not necessarily associated to size as departmental units with high teaching loads may significantly reduce their service activities and make it

very difficult for extra-departmental students to register. This is the case with Law and Pharmacy. Table 6 describes the departmental composition of the size dimension.

Table 6 - Zonal Composition of the Size of Activity Dimension

	Factor Scores			
	+ 2,0	1,6 to 2,0	1,0 to 1,5	0,5 to 1,0
Units	Law		Mathematics Secondary Education Pharmacy	Sociology Elementary Education Computing Science Criminology Economics Political Science Biology Biochemistry Industrial Relations Psychology Physical Education

The spatial variable "accessibility" is entirely absent of the rotated factor structure. One possible explanation is the low variation among units on this variable produced by the centroid method of calculating distances. Another explanation is that the variable distance is compatible with no other variable included in the analysis and corresponds to no significant dimension contained in the data of the attribute matrix. The second explanation seems most plausible in view of the low variability of other variables which nevertheless load high on certain significant dimensions of the analysis. It is not to say that accessibility should not be considered an important variable of spatial organization. On the contrary, the accessibility considerations that can be made from an analysis of the distance matrix and of the relative location of units suggest that distance should be an important spatial element especially in relation to inter-departmental interaction. See Figure 1 for a representation of accessi-

bility zones and of relative location of departmental units. This variable will be further analyzed in the following section.

Functional Organization

The use of principal component analysis on interaction data is to produce groupings of both destinations and origins in terms of the similarities of their linkage patterns.

The analysis of the first interaction matrix, the Optional Flow Matrix, produces four dimensions from which two are retained. The two dimensions account for 73,1% of the total variance (see Table 7).

Table 7 - Dimensions of Optional Flows

Dimensions	I	II
Eigenvalues	1,9	1,2
Percent Variance	45,4	27,8
Cumulative Percent Variance	45,5	73,1

The most dominant pattern of interaction among units centers on the two disciplinary areas identified as "Languages and Civilizations" and the "Humanities" (Table 8). The set of important origins as revealed by the factor score table are made of Translation, French and Linguistics on the one hand and Music, Anthropology, Philosophy, Ancient and Modern Studies and Ethnic Studies on the other hand (Table 9 and Appendix 2).

Table 8 - Rotated Factor Loadings on the Optional Flow Structure

	Dimensions	I	II	III
Flow Destinations	Basic Health Sc.	0,094	-0,187	0,787
	Humanities	0,772	0,594	-0,012
	Natural Sc.	-0,001	-0,347	0,357
	Social Sc.	0,055	0,308	-0,065
	Languages and Civ.	0,819	0,184	-0,042
	Arch. and Earth Sc.	-0,080	0,090	0,516
	Education	-0,076	0,029	-0,029
	Other Health Sc.	-0,094	-0,029	0,055
	Communication	0,156	0,673	0,089
	Social-Political Sc.	-0,106	0,210	0,008

The second dominant dimension embraces Communication and the Humanities as prominent destinations while the Social Sciences are secondary destination zones. Associated origins are French, History, Visual Arts and Political Science. At a second level of interaction stand Linguistics, Architecture and Philosophy. At a third level of interaction are Social Work, Sociology and the group composed of East Asiatic, Arab, Jewish and French Canadian Studies (Table 9).

Table 9 - Zonal Composition of the Optional Flow Structure

	Factor Scores			
First Dimension	+ 3	2,1 to 3,0	1,1 to 2,0	0 to 1,0
Flow Origins	Translation	French	Linguistics	Music Anthropology Philosophy Anc. & Mod. Studies Ethnic Studies
Second Dimension				
Flow Origins	French	History	Visual Arts Political Sc.	Sociology Social Work Philosophy Architecture Linguistics Ethnic Studies

The analysis of the second functional interaction matrix, the matrix of Total Flows produces 2 significant dimensions for a total explained variance of 77,4% (Table 10).

Table 10 - Dimensions of Total Flows

Dimensions	I	II
Eigenvalues	2,3	1,6
Percent Variance	45,2	32,2
Cumulative Percent Variance	45,2	77,4

The most dominant pattern of interaction for extra-departmental total flows centers on three disciplinary areas as major flow destinations. By order of importance, they are the Basic Health Sciences, the Para-Medical Sciences and the Social Sciences. This factor is a health-related one. Analysis of factor scores identifies as interacting origins departmental units which belong to the same health-related disciplinary areas. They are Pharmacy, Re-Education, Nursing, Dentistry and Biology. Less important flows originate from Nutrition and Speech Therapy. Interestingly, these flows can be identified with the compulsory element of total flows (Table 11 and Appendix 3).

The second dimension identifies three important flow destinations: the Humanities, Languages and Civilizations, and Communication. Significant interacting units are French, Translation, Linguistics and History. At a second level of interaction are Political Science, Visual Arts, Philosophy and the so-called Ethnic Studies. This factor is strinkingly resemblant to the first factor derived from analyais of the Optional Flow Matrix as it uncovers a similar pattern of significant flow origins and destinations (Table 11).

Table 11 - Zonal Composition of the Total Flow Structure

	Factor Scores			
First Dimension	+ 3	2,1 to 3,0	1,1 to 2,0	0 to 1,0
Flow Origins	Pharmacy	Dentistry Nursing Re-Education	Biology	Nutrition Speech Therapy
Second Dimension				
Flow Origins	Translation French		History Linguistics	Ethnic Studies Music Philosophy Visual Arts Political Sc.

To this point, three conclusions can be drawn from the functional analysis of extra-departmental flows. Firstly, the most significant flows at the University of Montreal are generated by compulsory course requirements embedded in the program structures. Secondly, analysis of the Total Flow Matrix reveals a bi-polarity between compulsory and optional flows, and only two significant dimensions for expressing the variance in the flow structure. Thirdly, a conclusion which is also emphasized by previous findings is that most of the observed interaction takes place between units belonging to the same or to closely related disciplinary areas.

Formal and Functional Spatial Organization

The principal hypothesis of this framework of analysis is that patterns of interaction may be explained in terms of organizational forms or conditions (attributes) which engender or might potentially engender interaction (flows). We are thus interested in the extent of interrelationships between the sets of

components uncovered by the formal and functional analyses and by the spatial dimension of these analyses (distance relationships).

As expected, attributes of the formal space are good predictors of functional interaction between departmental units. In particular, units scoring high on the "program structure" dimension of the formal space are those from which a major portion of the flows originates in the functional space. Similarly, those units with high levels of attraction on the second factor of the formal space are important destination areas in the functional space.

The relevance of these findings is important as the spatial analysis of formal attributes of departmental units uncovers a qualitative dimension of interaction. Structural characteristics of units such as expressed by the dimensions "program multidisciplinary breadth", "attraction", and "size of activities" can be advantageously used to improve the quality of space allocation on campus. Program multidisciplinary breadth may indicate interaction potential as well as dependency on the community for the provision of academic services. Attraction is a measure of utility with respect to the units or the groups of units which are served. Finally, size describes both self-reliance and potential for interaction. Functionnally, the structural characteristics of units can be further analyzed in terms of relative location of interacting units, origins with respect to destinations, accessibility and centrality. With these observations in mind, let us evaluate the soundness of the locational distribution of units on campus with respect to the principal dimensions of interaction brought out by this analysis.

Two spatial measures can be retained as general indicators of relative location and accessibility. One of them is a measure of <u>aggregate distance</u>

which is defined as the sum of all distances (in walking time) from each unit to every other unit on campus and is computed from the distance matrix. The aggregate distance yields information on the locational density of units and is shown on Fig. 1. Analysis of the accessibility map also indicates the presence of a decreasing interaction potential from zone (1) the Social Sciences and Humanities to zone (7), the Geography department. Zone 1 possesses the shortest aggregate distance from the units within it to all other units on campus. The second measure is a measure of centrality. It defines the zone and building which is most accessible on campus regardless of the location of departmental units (Fig. 2). Fig. 2 shows that the most central zone and building is not the one that has the highest functional accessibility as depicted on Fig. 1. Thus, the locational disadvantage of excentric units may to varying extent, impair their interaction with the highest centers of activity on campus. However, this relative disadvantage may be reduced if particular care is taken in locating functionally-dependent units in contiguous areas. Fig. 3 illustrates the discrepancy observed between functionally-dependent units and the relative location of those units.

Major locational inefficiencies are noticed with two particular flow patterns. The first one occurs with the most important flow destination of the Optional Flow structure, that is the disciplinary area identified as "Communication". Within this group, the faculty of Music and the department of Communication occupy excentric locations with respect to their client units located mostly in the Social Sciences and Humanities building.

The same observation holds true for departmental units related to the health sector dimension of the Total Flow structure. Interacting units are dispersed at very different locations on campus despite their high functional

FIG. 1 - FUNCTIONAL ACCESSIBILITY ZONES

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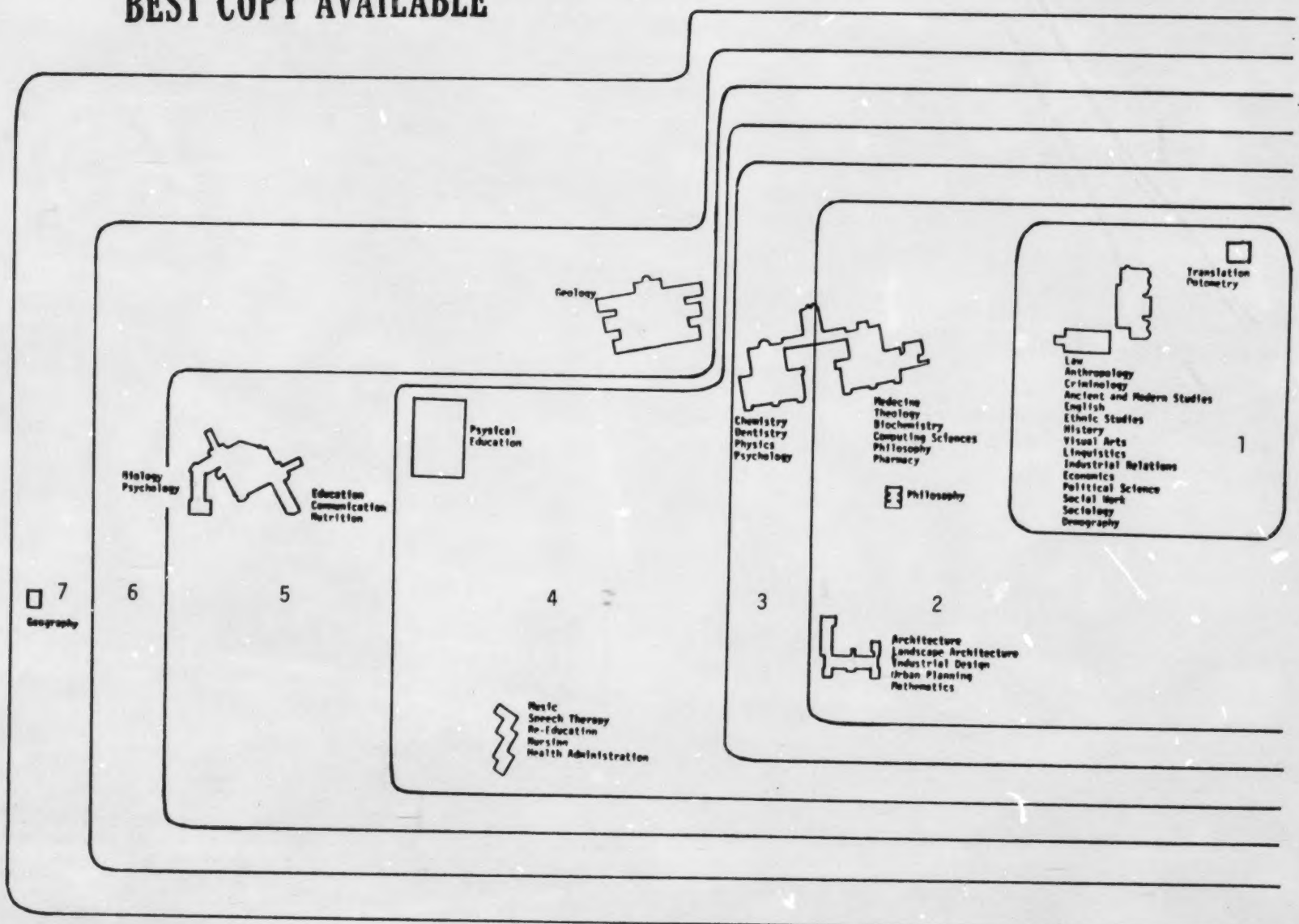

FIG. 2 - CENTRAL ZONES

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1 = most central zone

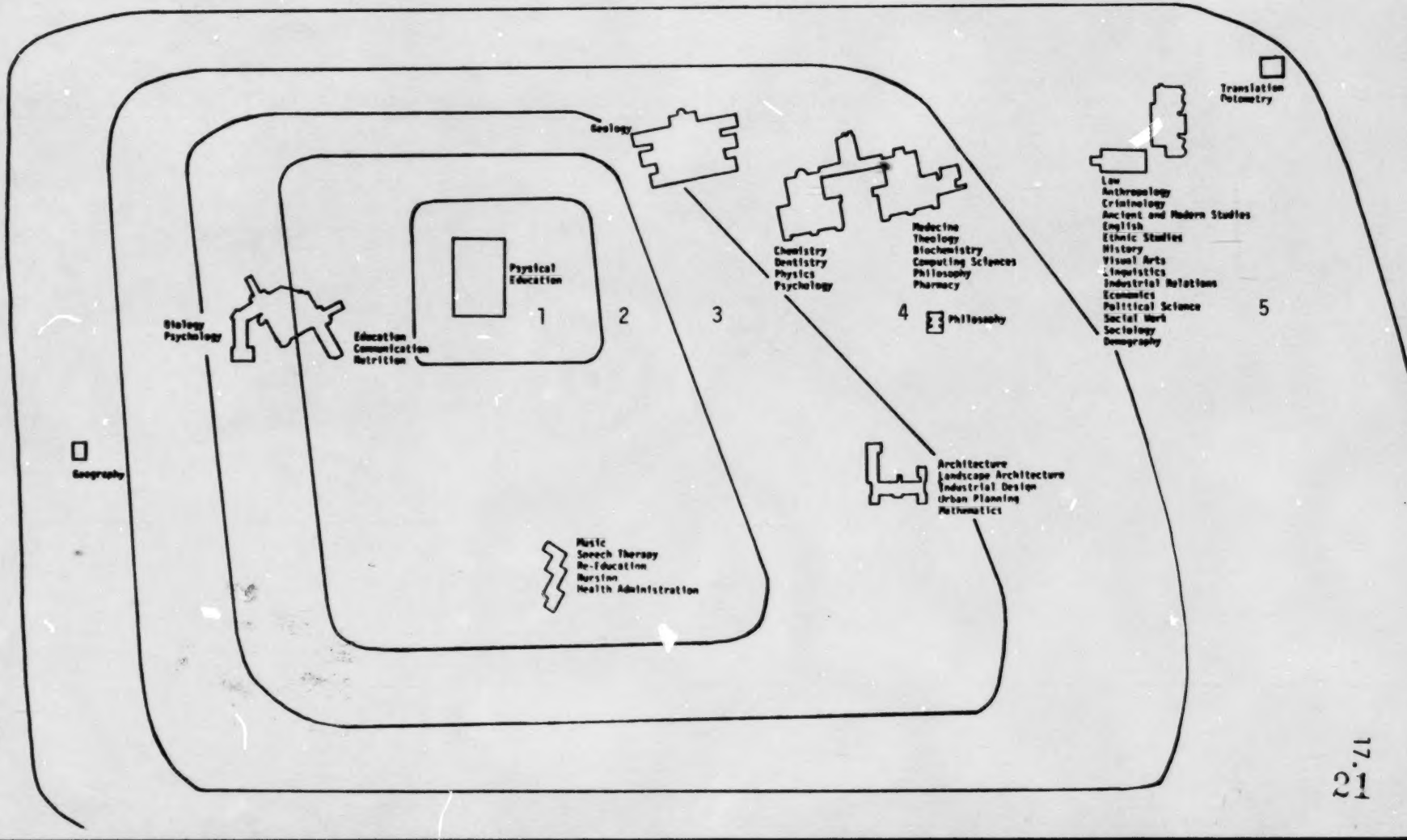
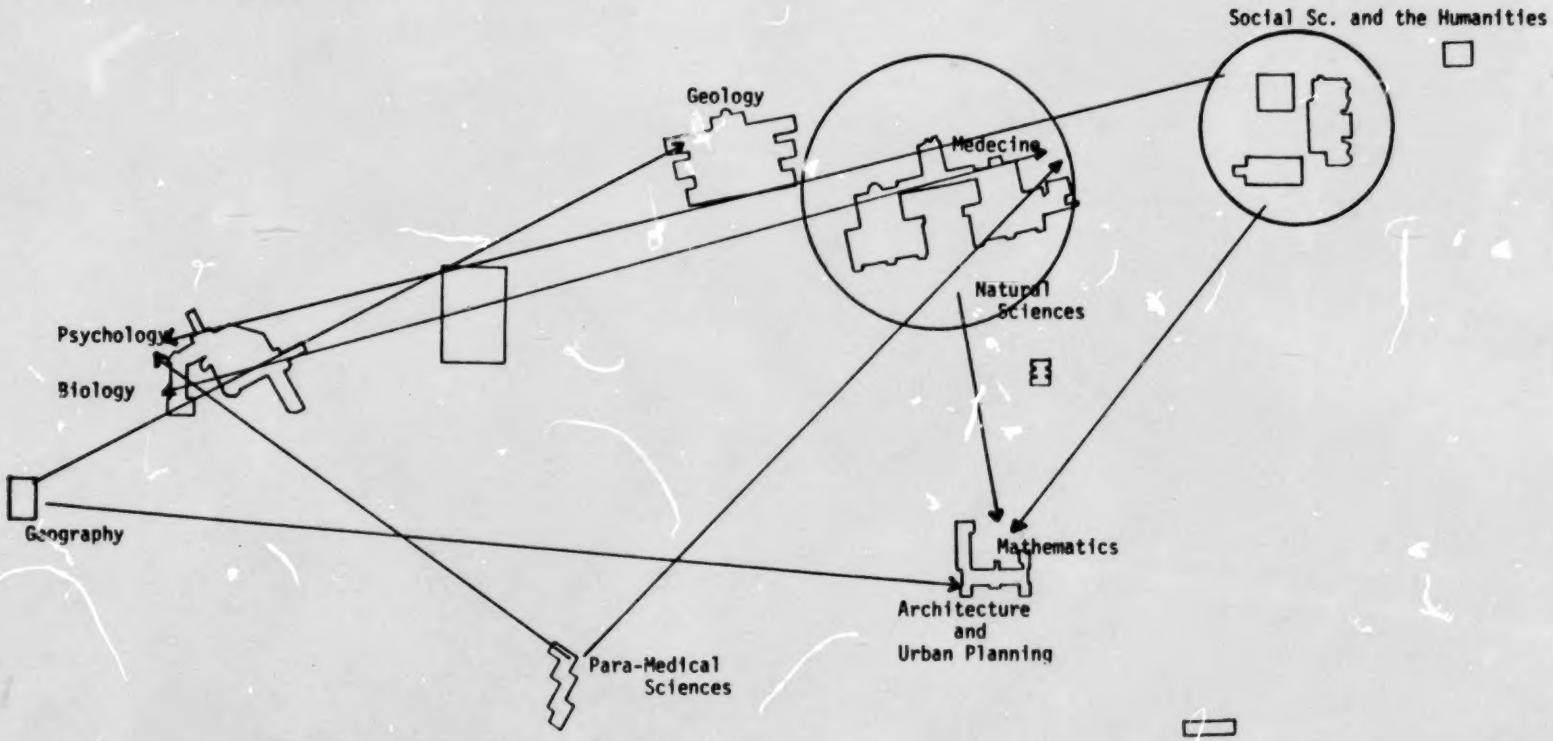


FIG. 3 - LOCATIONAL DISCREPANCIES OF FUNCTIONALLY-DEPENDENT UNITS OR DISCIPLINARY AREAS



interdependencies. This is a surprising finding in view of the supremacy of this sector in the flow patterns observed at the institutional level.

A unit-by-unit analysis of location patterns with respect to significant functional linkages also provides the means of evaluating minor discrepancies in the relative location of units. Mathematics for instance, whose role as a service course provider is important, is located very far from the relevant interacting units.

CONCLUSION

The present study has attempted to analyze some of the relationships between form and function. With respect to this objective, the factor analytic procedure has proven to be useful in providing a unique definition and identification of the spatial and functional structure of the flow system. Furthermore, the simultaneous use of factor loadings and factor scores has added a considerable amount of information about the derived structure, thus facilitating the identification of the resultant factors. Although the ultimate utility of factor analysis in a flow analysis context remains to be ascertained, the major strength of this technique lies in its ability to reduce a complex flow structure into significant and dominant flow dimensions that can be analyzed hierarchically. However, this technique cannot be used for inventory or micro-level planning for which a descriptive approach would seem more appropriate. Finally, alternative research tools are available to reduce large matrices into a set of homogeneous groups. Cluster analysis is one of the methodology which offers the greatest potential for its ability to partition a large population into disjoint or overlapping homogeneous classes.

Whereas the clustering technique yields tight clusters on the basis of the overall similarities of the units, the factor analytic method classifies units on the basis of a few significant dimensions.

The relevance of these methods and of their empirical findings is important for institutional planning. In formally acknowledging functional and spatial interdependencies, the inefficiencies and strength of the institutional network can be identified, reinforced or corrected on the basis of institutional goals. One should be aware, however, that adaptive behaviors may have taken place to compensate for some of the systems inadequacies. Increased mobility of the teaching staff, multiplication of service courses offered at the client unit location, decentralization of library resources are organizational elements which may have developed as responses to functional and spatial inefficiencies. They should be evaluated on the basis of their linkages with the system as a whole and with regard to the particular functional characteristics of the academic units involved. Improved accessibility, more centralized location for major service units, better clustering of complementary units are all measures which may bring to institutional life a qualitative dimension.

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Appendix 1 - Factor Scores on the Dimensions of Formal Spatial Organization

Zone	Description	Dimensions I	II	III
1	School Administration	3,407288	-0,026674	-0,118698
2	East Asiatic Studies	2,510917	-0,356396	-0,838897
3	English	0,579195	1,905390	-0,905557
4	Anthropology	-0,265956	1,094147	-0,246302
5	Landscape Architecture	-0,973037	-1,166588	-0,370573
6	Arab Studies	-0,412624	-1,028615	-1,488195
7	Architecture	-0,884466	-0,584013	0,084684
8	Health Administration	-1,017013	-1,116014	-0,027097
9	Biochemistry	3,438427	0,661824	0,768894
10	Biology	-0,007062	0,225133	0,752220
11	Chemistry	-0,066996	-0,664837	-0,118507
12	Communication	-0,360191	0,607265	-0,948868
13	Criminology	-0,421843	0,345704	0,643787
14	Dentistry	-0,041802	-1,105123	-0,232507
15	Secondary Education	-0,233359	-0,409388	-0,343553
16	Industrial Design	-0,969967	-1,021625	-0,456546
17	Evaluation in Education	0,830011	-0,115208	-0,558294
18	Demography	-0,858892	-0,117086	-1,038310
19	Law	-0,500398	-0,532877	4,234754
20	Ancient & Modern Studies	-0,269801	3,179043	-0,367201
21	Andragogy	-0,840225	-0,859774	-0,631177
22	Audio Visual Technology	1,124203	0,559761	-0,517016
23	Economics	-0,103398	0,604923	0,647906
24	Comparative Education	0,977347	-0,278677	-0,786496
25	Orthopedagogy	-0,549725	-0,413740	1,259480
26	Elementary Education	-0,358840	-0,636901	0,558284
27	Physical Education	0,139075	-0,200679	0,960607
28	French	-0,297861	0,609168	0,148374
29	Geography	0,270107	0,680835	-0,609590
30	Geology	-0,334376	-0,737575	-0,648480
31	Visual Arts	0,270705	1,377644	0,244793
32	History	-0,428616	1,346745	0,308181
33	Computing Science	0,443886	1,666595	0,625115
34	Jewish Studies	0,694816	-0,332211	-1,147869
35	Linguistics	-0,434988	-0,772111	-0,149627
36	Mathematics	-0,581975	1,255613	1,074155
37	Music	-0,744716	-0,193680	-0,255110
38	Nutrition	0,072602	-0,587808	-0,133993
39	Optometry	-0,308664	-1,201384	-0,277002
40	Speech Therapy	0,912449	-1,089366	-0,363185
41	Philosophy	-0,449717	1,419277	-0,671374
42	Pharmacy	0,003303	-1,386258	1,343682
43	Physics	0,146263	1,246300	-0,655231
44	Political Science	-0,257285	0,053190	0,674548
45	Psychology	-0,376332	1,948280	0,886599
46	French Canadian Studies	-1,054558	-0,507151	-1,414381
47	Re-Education	0,746236	-1,138793	0,319970
48	Industrial Relations	-0,165337	0,300055	0,838827
49	Nursing	0,956368	-0,781567	-0,246470
50	Sociology	-0,315300	0,915610	0,540789
51	Social Work	-0,665131	-0,420151	-0,283328
52	Theology	-0,688428	-0,366858	0,206654
53	Translation	-0,406292	-1,467105	0,181905
54	Urban Planning	-0,872830	-0,841014	-0,454775

Appendix 2 - Factor Scores on the Dimensions of Functional Organization - Optional Student-Credit-Hour Flows

Zone	Description	Dimensions I	II	III	IV
1	English	0,169994	-0,129468	-0,292515	-0,334643
2	Anthropology	0,018660	0,098129	0,077677	-0,070454
3	Health Administration	-0,423735	-0,450682	-0,274770	-0,413819
4	Biochemistry	-0,241975	-0,746884	0,036856	-0,094089
5	Biology	0,673188	-1,040752	4,948192	0,065744
6	Chemistry	-0,211441	-0,893592	0,272010	0,169931
7	Communication	-0,378557	-0,332252	-0,229437	-0,373833
8	Criminology	-0,286126	-0,380039	-0,284303	-0,441234
9	Dentistry	-0,380269	-0,380784	-0,262342	-0,550491
10	Demography	-0,376270	-0,460598	-0,256885	-0,419319
11	Law	-0,222814	-0,268369	-0,281745	-0,396815
12	Ancient & Modern Studies	0,366790	-0,589899	-0,317035	-0,499029
13	Economics	-0,054131	-0,797316	0,020020	1,649755
14	Physical Education	-0,615075	0,161266	-0,139073	-0,723904
15	French	2,492429	3,128694	0,154285	0,559816
16	Geography	-0,238400	-0,244124	-0,164513	-0,063197
17	Geology	-0,306015	-0,366242	-0,248057	-0,437061
18	Visual Arts	-0,769474	1,590513	0,338118	-0,322607
19	History	-0,370982	2,096422	0,035061	2,490936
20	Computing Science	-0,250081	-0,980807	-0,016522	1,366422
21	Linguistics	1,403642	0,927097	-0,221205	0,507376
22	Mathematics	-0,217721	-1,147521	0,133952	3,050933
23	Music	0,626119	0,359491	-0,278995	-0,032968
24	Nutrition	-0,411640	-0,433586	-0,119586	-0,538878
25	Optometry	-0,458696	-0,061600	-0,299436	-0,060076
26	Speech Therapy	-0,277389	-0,613932	-0,295844	-0,577403
27	Philosophy	0,395333	0,557787	-0,230249	0,038253
28	Pharmacy	-0,368276	-0,167867	-0,082201	-0,665200
29	Physics	-0,166803	-0,595907	-0,023201	0,065552
30	Political Science	0,093345	1,019551	-0,185475	0,569067
31	Psychology	-0,198697	0,334255	-0,030153	-0,184313
32	Re-Education	-0,607237	-0,123242	-0,264142	-0,661846
33	Industrial Relations	-0,442884	-0,286124	-0,301875	0,002982
34	Nursing	-0,388099	-0,443374	-0,262447	-0,479037
35	Sociology	-0,395889	0,467470	-0,109829	0,166522
36	Social Work	-0,241747	0,487357	-0,196406	-0,362757
37	Theology	-0,279676	-0,366542	-0,279581	-0,472531
38	Translation	4,438705	-0,024958	-0560566	-0,318584
39	Urban Planning	-0,437618	-0,275008	-0,151958	-0,376117
40	Education	-0,343545	0,113011	-0,253559	-0,475964
41	Ethnic Studies	0,459074	0,431512	-0,288731	-0,008812
42	Architecture	-0,776216	0,828912	1,186468	-0,348308

Appendix 3 - Factor Scores on the Dimensions of Functional Organization-Total Student-Credit-Hour Flows

Zone	Description	Dimensions I	II	III	IV	V
1	English	-0,473659	-0,124446	-0,986736	0,552910	-0,306156
2	Anthropology	-0,364153	0,050694	-0,072752	-0,160121	-0,187859
3	Health Administration	-0,513066	-0,732035	-0,352079	-0,152033	-0,324463
4	Biochemistry	-0,193401	-0,805184	-0,511491	0,053725	1,336465
5	Biology	1,584165	0,086700	-0,920237	-1,496077	1,777481
6	Chemistry	-0,482200	-0,735404	-0,371196	0,051237	0,451715
7	Communication	-0,447290	-0,576165	-0,241497	-0,082961	-0,377344
8	Criminology	-0,488298	-0,584852	-0,339501	-0,086388	-0,310089
9	Dentistry	2,217634	-0,371582	-0,339474	-0,367478	0,458611
10	Demography	-0,509215	-0,695733	-0,376854	-0,150208	-0,317914
11	Law	-0,488312	-0,475168	-0,297182	-0,154256	-0,234314
12	Ancient & Modern Studies	-0,456523	-0,186282	-0,702407	0,351874	-0,338428
13	Economics	-0,559810	-0,356187	0,277280	0,219899	0,815886
14	Physical Education	-0,069481	-0,403498	0,151482	0,490979	-0,922095
15	French	-0,047840	3,988382	-0,257771	-0,068803	0,307819
16	Geography	-0,478532	-0,247957	-0,112460	-0,621906	-0,061603
17	Geology	-0,545727	-0,642328	-0,345339	-0,049791	0,069602
18	Visual Arts	-0,305579	0,624401	0,227806	-1,319142	-0,702125
19	History	-0,202440	1,266851	2,267754	-0,440235	0,493786
20	Computing Science	-0,637009	-0,690851	0,125018	0,410198	1,111092
21	Linguistics	-0,314313	1,593271	0,264764	-0,167382	0,650560
22	Mathematics	-0,511969	-0,407369	0,739792	0,081524	0,598136
23	Music	-0,415935	0,556342	-0,085051	-0,227560	0,254631
24	Nutrition	0,344797	-0,727771	0,340139	-0,184001	0,285473
25	Optometry	0,098692	-0,451607	0,023002	-0,245756	0,249640
26	Speech Therapy	0,396933	-0,501612	-0,735212	2,314764	-1,637010
27	Philosophy	-0,354535	0,565191	0,194534	-0,142208	0,083440
28	Pharmacy	3,225529	-0,300993	-1,114181	-0,541199	0,349182
29	Physics	-0,561804	-0,587381	-0,306981	0,068791	0,565093
30	Political Science	-0,028991	0,758249	1,957833	0,477544	-0,192069
31	Psychology	-0,315490	0,050077	0,148676	-0,164166	-0,316467
32	Re-Education	2,646950	-0,194112	0,404672	0,598973	-0,559197
33	Industrial Relations	-0,427886	-0,764343	1,276087	0,170208	-0,008609
34	Nursing	2,503022	-0,294654	1,334433	0,981244	-0,630681
35	Sociology	-0,256761	0,065105	0,702243	0,142484	-0,307019
36	Social Work	-0,163216	0,082873	0,386373	0,193562	-0,522916
37	Theology	-0,489748	-0,583961	-0,374118	-0,133294	-0,298060
38	Translation	-0,153241	3,269495	-1,223623	1,866905	0,624191
39	Urban Planning	-0,502107	-0,638364	-0,281919	-0,245872	-0,322384
40	Education	-0,418254	-0,293699	-0,490152	-0,132514	-1,196558
41	Ethnic Studies	-0,421592	0,511230	0,049973	-0,282497	0,259950
42	Architecture	-0,419346	-0,095324	-0,033650	-1,410974	-0,670393